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FALSE BLOSSOM OF THE CULTIVATED CRANBERRY.

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CONTENTS.

Page.
Introduction 1
Description of false blossom 1
Origin and distribution 3
Economic importance 4
Cause 4
Control 5
Summary 5
Literature cited 7

INTRODUCTION.

For a number of years past an abnormal development of vines of the cranberry (*Oxycoccus macrocarpus*) has caused considerable loss in cranberry marshes, especially in the district about Grand Rapids, Wis. The trouble is commonly called false blossom by the growers. Since this term is so generally used in Wisconsin and is somewhat applicable to the disease, it is probably best to adopt it as the common name. It should be explained, however, that a disease of an entirely different nature, caused by *Exobasidium oxycocci* Rost., has received the same name among Massachusetts growers. The name rose-bloom is proposed for this latter disease.

DESCRIPTION OF FALSE BLOSSOM.

The disease under consideration produces as one of its most conspicuous features a malformation or metamorphy of the floral organs. It was briefly described by the writer (10)[1] in 1911. In the simplest form of the trouble the flower pedicels become more or less erect instead of drooping and the calyx lobes become enlarged, greenish, and somewhat foliaceous. The petals become shortened, broadened,

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[1] The figures in parentheses refer to "Literature cited" at the end of the paper.

NOTE.—This bulletin is of interest to plant pathologists and to cranberry growers, especially in the States of Massachusetts, New Jersey, Wisconsin, and the coastal regions of Oregon and Washington.

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and slightly reddish or greenish in color, as shown in Plate I, figure 2, *b* and *c*. The stamens and pistil are more or less aborted and malformed and no fruit is produced. Plate I, figure 1, shows normal flowers for comparison.

All intermediate gradations of phyllody can usually be found among diseased vines, from the simple form, in which there is only a shortening and thickening of the parts of the perianth, to cases in which the entire flower is replaced by a short branch with small leaves, as shown in Plate II, figure 1, *c, d,* and *e*.

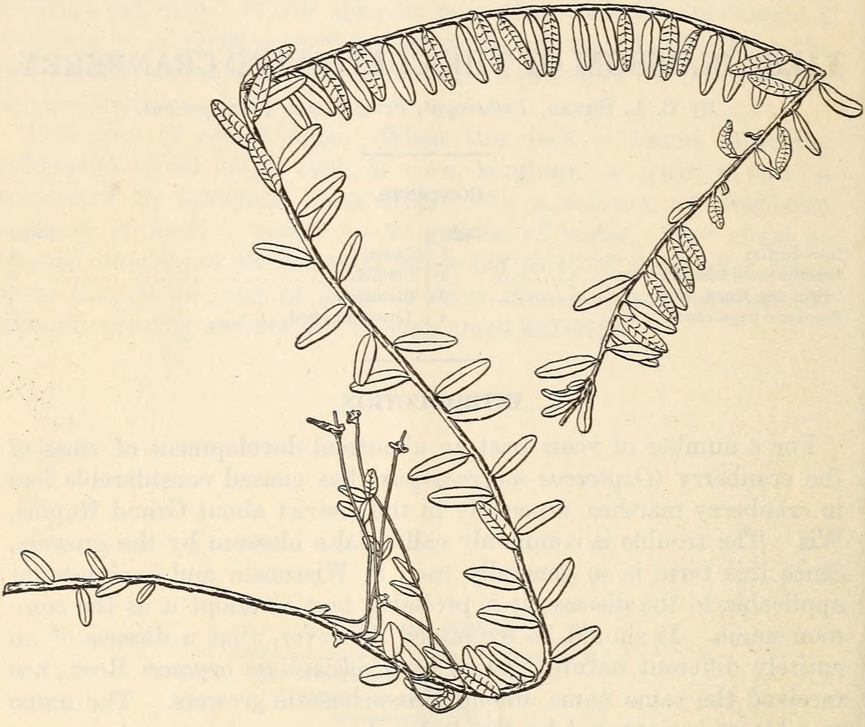

FIG. 1.—A cranberry plant in which the terminal bud has developed into a runner instead of a fruiting bud.

Plate III shows a condition in which the different floral organs are represented by whorls of green, leaflike structures on the prolonged axes. Besides the transformation of the floral organs, other abnormalities of growth are usually found. Plate IV shows details of a malformed flower and various conditions of development of leaflike bodies in whorls on the prolonged floral axis. Affected plants have a great tendency to develop lateral branches from the usually latent axillary buds situated on the vine below the fruit bud, as shown in figure 1. The branches are slender and weak and fail to produce normal flowers or fruit. They give the plant a kind of witches'-broom appearance. In some instances the end of the flowering shoot, instead of forming a fruit bud for the next season, as is the case in normal plants, continues to grow and produces a long, slender runner, as shown in figure 2. Cranberry plants in bogs where this malformation occurs generally show an excessive vegetative growth, usually forming a deep, dense mass of vines.

In their dormant condition the terminal buds are frequently enlarged and abnormal and die during the winter. Under some conditions the plants produce few runners.

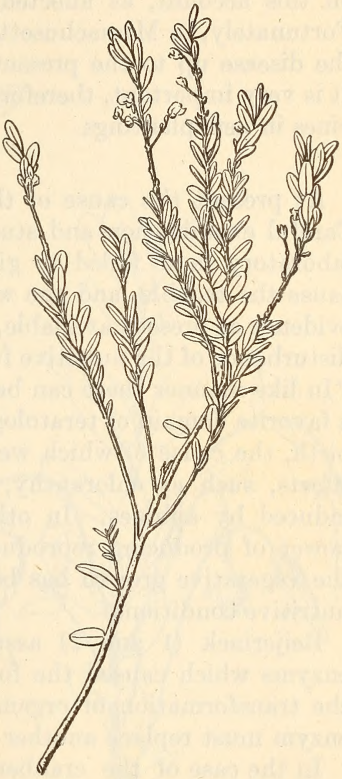

FIG. 2.—A cranberry plant in which the normally dormant axillary buds have developed into shoots.

ORIGIN AND DISTRIBUTION.

All the data at hand seem to indicate that this disease first appeared in Wisconsin. Cases of phyllody have been found in Massachusetts, New Jersey, Oregon, and Washington, but most cases appear to be traceable to vines obtained from Wisconsin. No printed reference to this disease has been found by the writer previous to his brief mention of it (9) in 1908. The disease has, however, undoubtedly been present in Wisconsin for many years.

The first cases of the disease discovered in Massachusetts were examined by Dr. H. J. Franklin and the writer in 1914 and have been reported by Franklin (3). Affected vines were observed in five different bogs. In four cases the vines were of the variety known as Metallic Bell, which had been obtained from Wisconsin. In the fifth case the variety was unknown, but this also had come from Wisconsin. These vines had been planted about 10 years previously. The next year, 1915, the writer's attention was called to the occurrence of this disease in New Jersey. In this case the plants were of the Jumbo variety obtained from Wisconsin and planted several years previously.[1] In both Massachusetts and New Jersey a few scattered vines showing the disease have been found in plantings of eastern varieties in the same bog, but whether these diseased vines are really eastern plants or have arisen from Wisconsin cuttings is very difficult to determine, since plants affected with false blossom rarely develop normal fruit. This has raised the question of the possible infectious nature of the disease.

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[1] Since this was written the disease has been found in other bogs in New Jersey under such conditions as to suggest that the disease may have developed there independently.

ECONOMIC IMPORTANCE.

This disease is an important factor in reducing the crop of cranberries in Wisconsin. In some bogs one-half of the crop may be lost on this account, as affected vines rarely produce any good fruit. Fortunately, in Massachusetts, New Jersey, and on the Pacific coast the disease up to the present time is confined to very small areas. It is very important, therefore, to avoid the introduction of diseased vines in new plantings.

CAUSE.

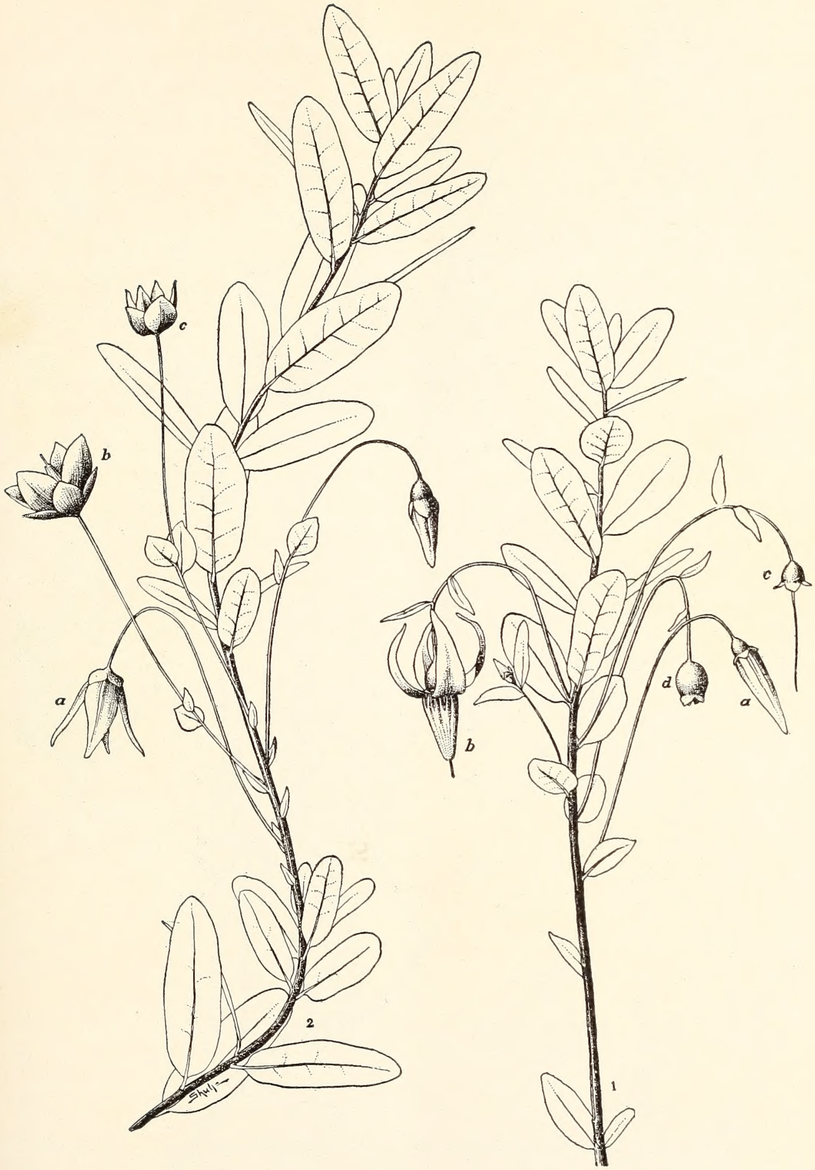
At present the cause of this pathological condition is uncertain. Careful examination and study of many specimens in the field and laboratory have failed to give any evidence that insects or fungi cause the trouble, and the writer has come to believe, from all the evidence at present available, that it is primarily due to some serious disturbance of the nutritive functions of the plant. Goebel (4) says: "In like manner there can be no doubt that the phyllody of flowers, a favorite domain of teratology, is a symptom of disease; it is a misbirth, the cause of which we do not know in most cases." Similar effects, such as chloranthy, as Peyritsch (8) has shown, may be induced by aphides. In other cases it may be assumed that the power of producing reproductive organs has been enfeebled, while the vegetative growth has been abnormally stimulated through the nutritive conditions.

Beijerinck (1 and 2) assumed the existence of certain growth enzyms which caused the formation of normal organs. In case of the transformation of organs, according to his theory, one growth enzym must replace another or be formed instead of it.

In the case of the cranberry it seems possible that this striking metamorphy is due to some serious disturbance of the nutrition of the plant. A similar opinion was also expressed by Jones and Shear (5) as the result of a joint field study of the disease. Mr. Malde (6), who has observed this trouble for many years in Wisconsin, says:

> The dryness of the season seems to have reduced the amount of "false blossom" this year, and from the data gathered in the Mather region, it has become more evident than ever that this so-called "false blossom" is due to conditions of culture rather than any disease affecting the plant.

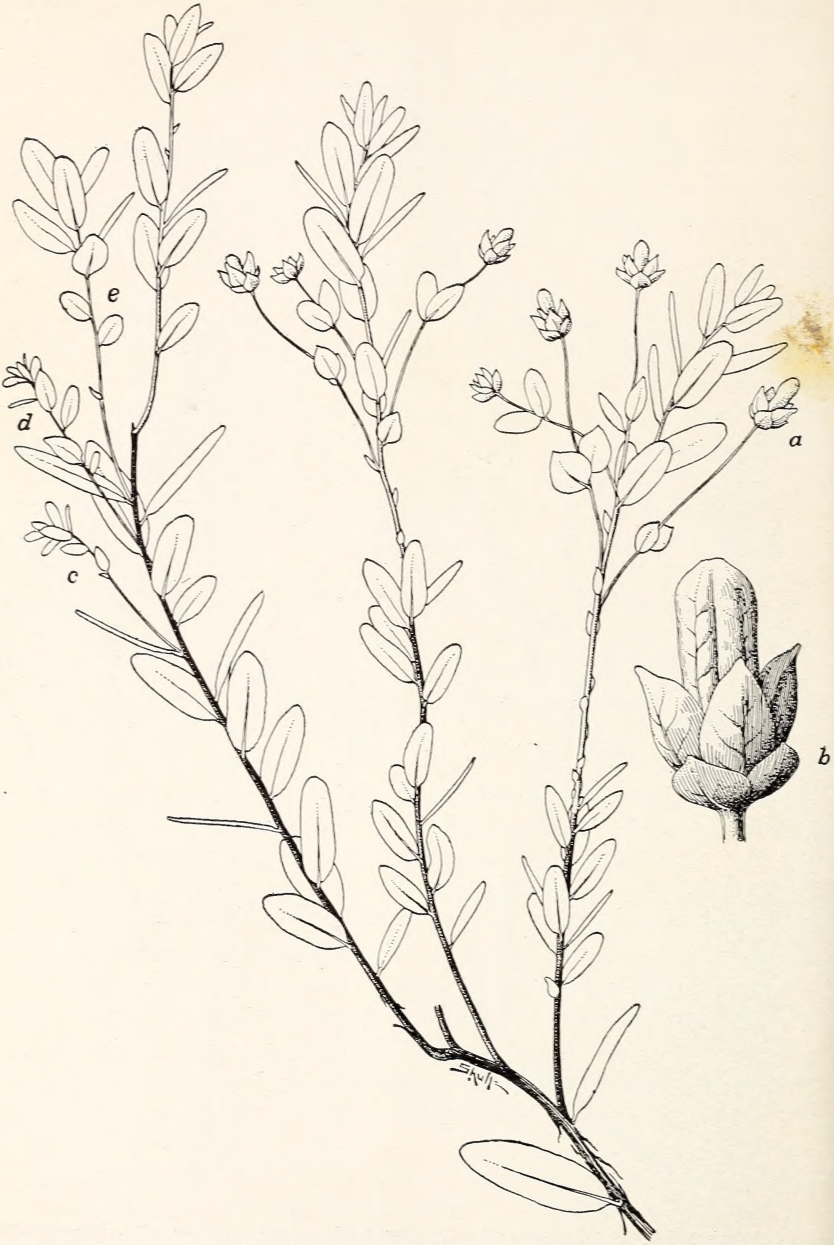
In all the localities in Wisconsin in which the writer has observed this malformation, there has been a deep, coarse, peat soil, supplied with an excessive amount of water during the greater part of the growing season. Of course these peat bottoms contain vast quantities of nitrogenous matter, but not in such form as to be available to ordinary farm crops. The cranberry, however, is regarded by physiologists as obtaining its nutriment chiefly by means of the endophytic mycorrhiza of its roots and may be able to secure an abundance of



A Normal Fruiting Branch of a Cranberry Vine and a Shoot with Malformed Flowers.

Fig. 1.—A fruiting branch of a cranberry vine with normal flowers in different stages of development: *a*, An unopened bud; *b*, an open flower; *c*, the young fruit just after the blossom has fallen; *d*, young fruit.

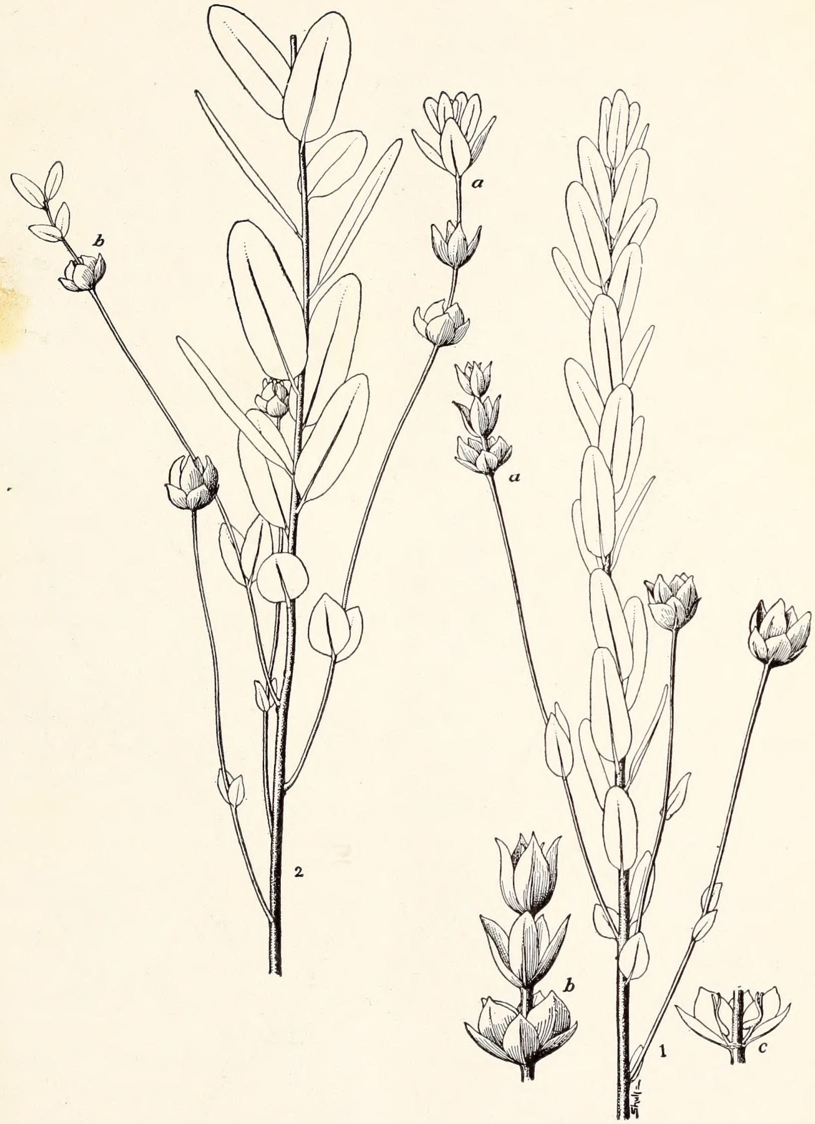
Fig. 2.—A cranberry shoot, showing the simplest forms of malformation of flowers: *a*, A flower with the calyx lobes somewhat broader than normal and the petals much shortened and broadened; *b*, a flower with the sepals broadened and divided to the base; the petals are also short, broad and virescent, approaching a foliaceous condition; the stamens are somewhat shortened and abnormal, and the ovary abnormal, elongated into a conical form, and infertile; *c*, a condition very similar to that shown in *b*. These illustrations were made from plants collected near Grand Rapids, Wis., on June 29, 1907.



A Portion of an Upright Branch of a Cranberry Vine in Which the Terminal Bud, Which Normally Produces a Flowering and Fruiting Shoot, Failed to Develop. In Its Stead Three Shoots Arose from Normally Dormant Axillary Buds.

a, An abnormal flower in which the sepals are short, broad, virescent, and divided at the base; petals short, broad, and mostly virescent; stamens present, but shortened and somewhat abnormal in form. The ovary is prolonged into a columnar form, is virescent, and shows four depressed lines representing points of origin of the division walls of the ovary, which easily ruptures along these lines; *b*, an enlarged figure of the same flower; *c*, *d*, and *e*, flower pedicels in which the floral organs have all been transformed into small foliaceous structures, *e* representing the most advanced condition of this transformation, in which, instead of a flower, an almost normal foliaceous shoot is produced.

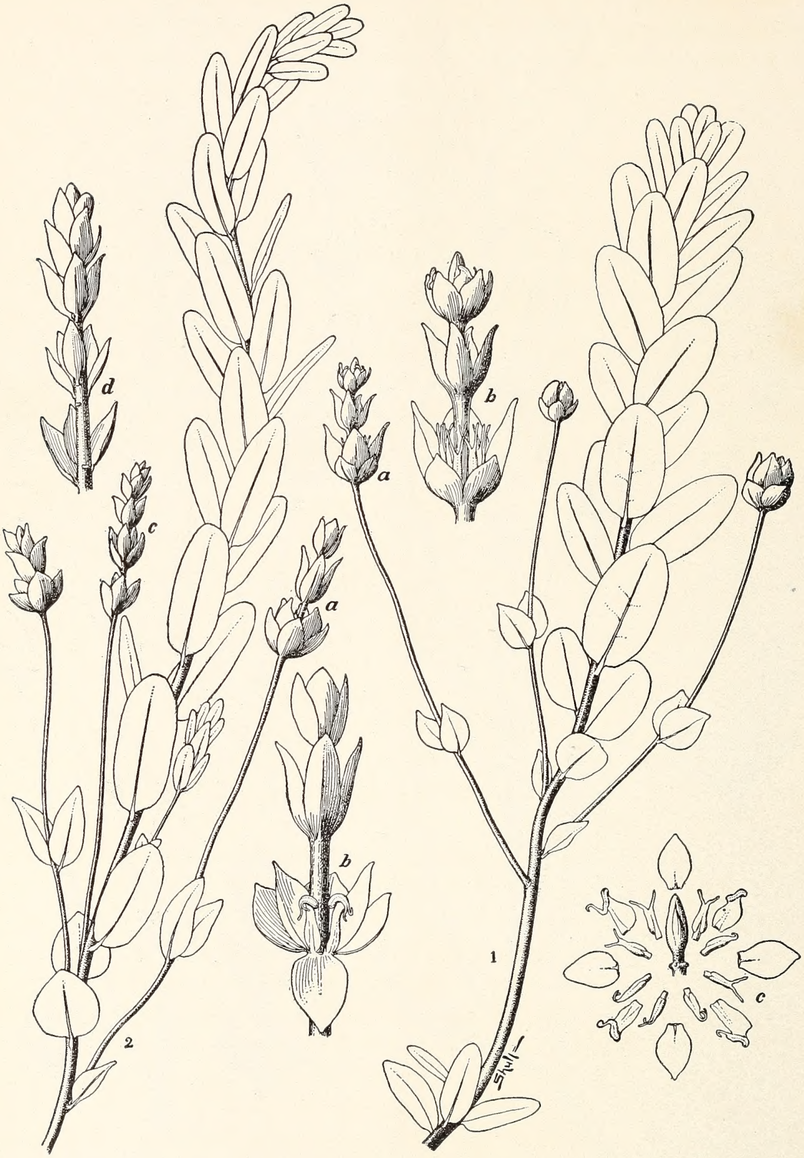
PLATE III.



Flowering Shoots of Cranberry Vines, Showing Various Stages of Phyllody.

Fig. 1.—A flowering shoot with three different stages of phyllody: *a*, The most pronounced condition, in which sepals and petals are abnormal in form and virescent. Instead of an ovary, the axis is elongated, bearing a whorl of four small, green, leaflike bodies, and this is followed by another similar whorl, within which are two other partially developed organs of the same kind; *b*, an enlarged figure of the same, and, *c*, a section of the basal whorl, representing sepals and petals, showing the condition of the anthers, which were present in a somewhat abnormal form in almost all cases except in the condition represented in Plate IV, *c*, and also in Plate II, *c*, *d*, and *e*.

Fig. 2.—A flowering shoot in which two of the flowers are still more greatly transformed: *a*, In this case the axis of the flower, after being prolonged and bearing a whorl of small, green, leaflike bodies, is continued, producing a series of small leaves, the lower more or less whorled, but those above tending toward an alternate arrangement similar to that of a normal shoot; *b*, a form in which the elongated axis has all the small leaflike bodies more or less alternately arranged. In all these cases, abnormal stamens were present in their normal position.



TRANSFORMATIONS OF FLOWERS OF THE CRANBERRY IN VARIOUS STAGES OF PHYLLODY.

FIG. 1.—Modifications of the transformation of flowers: *a*, The flower with green, abnormally shaped sepals and petals; the axis prolonged, bearing two whorls of small, green, leaflike bodies, the upper whorl with eight abnormal stamens, the lower also with stamens; *b*, an enlarged view of *a*; *c*, the upper whorl of *b*, dissected, showing the abnormal floral organs. Within the outer whorl of four short, broad bodies, were four much malformed organs, showing the condition intermediate between an aborted petal and a stamen. Within this whorl were eight abnormal stamens and at the center a partially opened bud, with two small, partially developed leaflike organs.

FIG. 2.—A shoot in which the flowers are still further transformed: *a*, All the parts of the flower except the stamens are green and more or less leaflike; *b*, an enlarged view of *a*, showing the condition of the stamens; *c*, a stage in which the parts, instead of being arranged in whorls, are more or less alternate or spiral; *d*, an enlarged view of *c*. There is no sign of stamens present in any of these groups of small, green, leaflike bodies in *c*, the stamens being apparently the last organ to disappear in the metamorphosis of the flower.

nitrogen from these soils, as it usually shows great luxuriance of vegetative growth where the water supply is abundant. Mr. Malde (7) corroborates this view and states that the development of the disease appears also to be favored by extreme drought or lack of water.

CONTROL.

It appears from experiments conducted by Mr. Malde at the Wisconsin Cranberry Station and reported to the writer that malformed plants when transplanted and kept under more favorable conditions tend to return to the normal form. The writer has been told by a grower on the Pacific coast that plants from Wisconsin showing phyllody have entirely recovered from the disease when grown on that coast. The cases in Massachusetts previously mentioned indicate, however, that under rather favorable conditions of cultivation in the Eastern States the disease persists for a long time in affected vines.

Owing to the obscure nature of this disease and the difficulties involved in carrying out satisfactory experiments to determine definitely its cause and nature, but little has yet been accomplished in this direction. On the basis of the present theories of the cause of the trouble, recommendations have been directed chiefly toward correcting and making as nearly optimum as possible the soil and nutritive conditions under which the plants are grown, as indicated in the writer's papers presented at the Wisconsin State Cranberry Growers' Association (9 and 11). This involves sanitary measures, such as clean cultivation, thorough drainage, pruning, and fertilization where needed. In cases where half or more of the plants in an area are affected, it is best to mow off the vines, properly drain the bog, and apply ground rock phosphate, which Mr. Malde believes beneficial. In bad cases it will probably be best to scalp the bog and replant with healthy vines (11).

Experiments have been undertaken in Massachusetts to determine definitely whether the transmission of the disease to normal plants when grown in contact with diseased plants is possible.

Plants from diseased bogs should be carefully avoided in making new plantings. Even though under optimum conditions of growth the plants may outgrow the trouble in time, they will not produce a profitable crop as soon as healthy vines.

SUMMARY.

The disease known locally as false blossom in Wisconsin is a true case of phyllody.

The floral organs show all degrees of transformation from normal flowers to those in which the parts are all changed to green leaflike bodies and the axis prolonged into a shoot.

The disease appears to have originated in Wisconsin, but has become established in Massachusetts, New Jersey, Oregon, and Washington by transplanting diseased vines.

The cause is not known. No evidence has yet been obtained to indicate that it is produced by insects or fungi.

It is suggested that the disease may be due to unbalanced nutritive conditions.

The disease is perpetuated from year to year in plants reproduced vegetatively from diseased plants, not only in bogs where the trouble originated, but also under somewhat more favorable conditions of cultivation in localities in which the disease was unknown previously. Observations made by Mr. Malde in Wisconsin and by a grower in Oregon seem to indicate that the offshoots from plants affected with false blossom tend to recover and become normal when transplanted and grown under optimum soil and moisture conditions.

To overcome the disease, optimum conditions for growth should be provided, including good drainage, clean culture, and pruning.

Where diseased plants are numerous, the bog should be scalped and replanted with healthy vines.

To prevent the further spread of the disease only vines known to be absolutely free from it should be planted.

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